









AUDIENCE RATING SYSTEM FOR DIGITAL TELEVISION AND RADIO**Publication number:** WO9962260 (A1)**Publication date:** 1999-12-02**Inventor(s):** MASSETTI ENRICO EMILIO [US]**Applicant(s):** MASSETTI ENRICO EMILIO [US]**Classification:****- international:** *H04H60/37; H04H60/40; H04N5/00; H04H1/00; H04N5/00;*
(IPC1-7): H04N7/16**- European:** H04N5/00M6; H04H60/37; H04H60/40**Application number:** WO1999US10453 19990521**Priority number(s):** US19980085501 19980527; US19990289758 19990412**Also published as:** CA2323937 (A1) EP1090504 (A1) BR9909273 (A) AU4184599 (A)**Cited documents:** US5872588 (A) US5594934 (A) US5532732 (A) US5659350 (A)**Abstract of WO 9962260 (A1)**

An audience rating system for digital television and radio, using identification codes in control streams (C) of time-multiplexed digital transmissions (12). When a television set (22) or radio, that is being monitored pursuant to the system is turned on and tuned to a channel, and each time that the channel is changed, an identification code for each audio, video or auxiliary digital stream of the channel is extracted from the control stream, and recorded along with the time. The time is also recorded when the television set or radio is turned off. This data makes it possible to determine what stations, channels, and programs members of the audience being monitored are watching or listening to at any particular time.

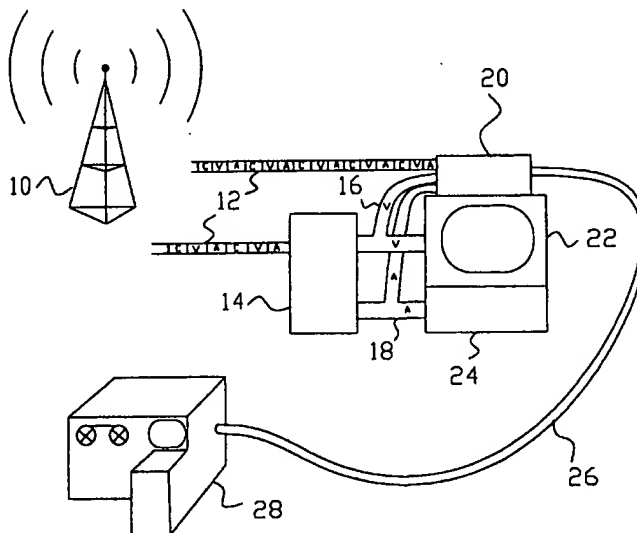
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(57) Abstract

An audience rating system for digital television and radio, using identification codes in control streams (C) of time-multiplexed digital transmissions (12). When a television set (22) or radio, that is being monitored pursuant to the system is turned on and tuned to a channel, and each time that the channel is changed, an identification code for each audio, video or auxiliary digital stream of the channel is extracted from the control stream, and recorded along with the time. The time is also recorded when the television set or radio is turned off. This data makes it possible to determine what stations, channels, and programs members of the audience being monitored are watching or listening to at any particular time.

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AUDIENCE RATING SYSTEM FOR DIGITAL TELEVISION AND RADIO

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to methods and apparatus
5 for audience rating systems for digital television and
radio.

2. DESCRIPTION OF THE PRIOR ART

The television and radio industries and commercial
advertisers have an obvious interest in knowing how many
10 people are watching or listening to particular stations and
programs. Various systems of audience rating have been
developed for analog television and radio, of which the
most accurate use a meter that is connected to the
television set or radio, that records when the receiver is
15 turned on and off, and what channels or frequencies it is
tuned to. Digital television and radio are now being
introduced, and are expected to eventually completely
replace analog television and radio. The existing rating

devices for analog television and radio either will not work at all with digital television and radio, or will work only poorly. The present invention is a method of audience rating for digital television and radio, that uses an apparatus that can be connected to a digital television set or radio. It makes use of identification codes in the control stream of multiplexed digital transmissions to record the channel being received.

U.S. Patent No. 4,547,804, issued on October 15, 1985, to Burton L. Greenberg, discloses a method and apparatus for the automatic identification and verification of commercial broadcast programs. A digital encoded identifying number is embedded in the programs, by which they can be automatically monitored, to verify that they have been broadcast as and when intended. However, the digital number is embedded in what is otherwise an analog program. This method is usable only during the transition period from analog to digital broadcasting technology, when some digital equipment or connection is in use together with older analog equipment or connections. It will not work when the broadcasting stations have fully digital operations, e.g., recording a program in digital form, storing it digitally on tape or disk, performing nonlinear

digital edits and digital commercial insertions, and transmitting digitally in the air, or delivering a digital stream to a cable or satellite operator to multiplex with other digital streams. The instant invention is distinguishable, in that it is fully digital and will work with broadcasting that is fully digital, and it is designed for audience ratings, rather than broadcast verification.

U.S. Patent No. 4,647,974, issued on March 3, 1987, to Robert J. Butler and Ronald G. Schlameuss, discloses a system for the automatic insertion of auxiliary video information into an analog television signal. The system may be used by a local station to insert its call letters or logo into network programming. The instant invention is distinguishable, in that it uses digital signals in digital broadcasts, and is designed to monitor receivers.

U.S. Patent No. 4,697,209, issued on September 29, 1987, to David Kiewit and Daozheng Lu, discloses a method and apparatus for identifying television programs, by detecting the occurrence of events such as scene changes in a video signal, and extracting a signature from the signal. Signatures and their times of occurrence are stored and compared with reference signatures to identify the program. As the system is independent of the format used to transmit

the signal, it will work with both analog and digital television. It has the disadvantage of requiring that a large volume of reference data be collected for every possible station and program being transmitted, and for every site monitored, which will require a large computing capacity and a long computing time to correlate the two sets of data to determine which station or program is being received at each monitored site at each instant that each receiver is turned on. The instant invention is distinguishable, in that it is designed to monitor the reception of digital transmissions only, and will work efficiently with such transmissions, by using identification codes in their control streams.

U.S. Patent No. 4,972,503, issued on November 20, 1990, to Everett V. Zurlinden, discloses a method and apparatus for determining the channel to which a remotely controlled television receiver is tuned. While it is independent of the format (analog or digital) used to transmit the signal, its implementation on a mass scale for audience ratings will not be practical, as it requires an individual hardware or software adaptation to each remote control used in the monitored sites to determine what function is activated when a key pressing is detected. The

instant invention is distinguishable, in that requires no such adaptation to remote controls, and may be implemented even if a remote control is not used.

U.S. Patent No. 5,019,899, issued on May 28, 1991, to
5 Glenn M. Boles et al., discloses an electronic data encoding and recognition system for creating digital signatures from frames of selected video segments such as television commercials by a digitalizing, compression and selection process which produces a multi-digit signature
10 from each frame. The instant invention is distinguishable, in that it uses digital signals in digital broadcasts, and may be used to monitor receivers.

U.S. Patent No. 5,278,988, issued on January 11, 1994, to Jean P. Dejean, Enrico Massetti, Ken Straub and Everett
15 Zurlinden, discloses a method and apparatus for determining the transmitting station from which analog program signals are received and translated by a monitored receiver within a test area. The instant invention is distinguishable, in that it is designed to detect and record the reception of
20 digital transmissions by digital receivers.

U.S. Patent No. 5,425,100, issued on June 13, 1995, to William L. Thomas, Paul C. Kempter and David H. Harkness, discloses a multi-level encoded signal monitoring system

and a universal broadcast code for identifying programs, commercial, networks, stations, etc. The instant invention is distinguishable, in that it is designed for and will work with fully digital programming, and does not require multiple levels of encoding.

U.S. Patent No. 5,450,122, issued on September 12, 1995, to Leonard D. Keene, discloses an in-station method and apparatus for encoding analog television programs, including commercials, with a digital identification code recorded on a selected video scan line which is not normally visible to the television viewer, and for verifying the proper airing of such programs by television broadcast stations. The instant invention is distinguishable, in that it is designed for determining audience ratings for digital television and radio.

U.S. Patent No. 5,450,490, issued on September 12, 1995, to James M. Jensen et al., discloses apparatus and methods for including an inaudible code in an analog audio signal, and for decoding it. The instant invention is distinguishable, in that it uses identification codes in the control streams of multiplexed digital transmissions.

U.S. Patent No. 5,512,933, issued on April 30, 1996, to Mark A. Wheatley and Peter Wilcox, discloses a system

for identifying a program stream being displayed at a receiver location, by measuring the relative luminance of a plurality of predetermined areas in each frame of a television transmission, at both the transmitting station and the receiver. As the system is independent of the format used to transmit the signal, it will work with both analog and digital television. But, as with Kiewit et al., *supra*, it has the disadvantage of requiring that a large volume of reference data be collected for every possible station and program being transmitted, and for every site monitored, as well as requiring a large computing capacity and a long computing time to correlate the two sets of data to determine which station or program has been received at each monitored site at each instant that the receiver was turned on. As before, the instant invention is distinguishable, in that it is designed to monitor the reception of digital transmissions only, and will work efficiently with such transmissions, by using identification codes in their control streams.

U.S. Patent No. 5,574,962, issued on November 12, 1996, to Michel Fardeau et al., discloses a method and apparatus for automatically identifying a program, by adding an inaudible encoded message to the audio signal.

The instant invention is distinguishable, in that it is designed for multiplexed digital transmissions, and uses identification codes already present in their control streams.

5 U.S. Patent No. 5,646,675, issued on July 8, 1997, to Robert C. Copriviza et al., discloses a system and method for monitoring the reception of video program material, using codes inserted on scan lines. Again, the instant invention is distinguishable, in that it is designed for
10 multiplexed digital transmissions, and uses identification codes already present in their control streams.

None of the above inventions and patents, taken either singly or in combination, is seen to describe the instant invention as claimed.

15

SUMMARY OF THE INVENTION

The present invention is an audience rating system for digital television and radio, using identification codes in control streams of time-multiplexed digital transmissions. When a television set or radio, that is being monitored
20 pursuant to the system, is turned on and tuned into a channel, and each time that the channel is changed, an

identification code for each audio, video or auxiliary digital stream of the channel is extracted from the control stream, and recorded along with the time. The time is also recorded when the television set or radio is turned off.

5 This data makes it possible to determine what stations, channels, and programs members of the audience being monitored are watching or listening to at any particular time. In the first preferred embodiment, the multiplexed digital transmission is received separately by the

10 television set or radio (or an attached integrated receiver and decoder) and a meter connected to it. The meter compares the elementary digital streams of the channel being received by the television set or radio with digital streams of each of the channels in the multiplexed digital

15 transmission, until it finds a match. In the second preferred embodiment, the meter does not receive the multiplexed digital transmission separately, but has access to an elementary stream extracted from the multiplexed digital transmission by an integrated receiver and decoder.

20 In both embodiments, the meter extracts identification codes for the channels being received from the elementary stream. The elementary stream may be accessed through an auxiliary connector in a digital decoder, through an access

control card connector, or through soldering electrical connections to internal points in the integrated receiver and decoder. In either embodiment, the digital transmission may be either a terrestrial or satellite broadcast, or by cable. The data recorded may be stored on-site in the meter's memory, and/or transmitted to a central computer for immediate processing. While designed as an audience rating system, the invention may also be used in recording reception of, and billing customers for, pay-per-view digital television programs (or even "pay-per-listen" digital radio programs, should any be developed).

Accordingly, it is a principal object of the invention to provide an efficient means of creating reliable audience rating reports for digital television.

It is another object of the invention to provide an efficient means of creating reliable audience rating reports for digital radio.

It is a further object of the invention to provide a means for recording reception of digital programs for which a fee is charged to the consumer.

It is an object of the invention to provide improved elements and arrangements thereof in an apparatus for the purposes described which is inexpensive, dependable and

fully effective in accomplishing its intended purposes.

These and other objects of the present invention will become readily apparent upon further review of the following specification and drawings.

5

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a flowchart showing the method of the first preferred embodiment of the invention.

Fig. 2 is a schematic diagram showing the apparatus used in the first preferred embodiment of the invention.

10 Fig. 3 is a flowchart showing the method of the second preferred embodiment of the invention.

Fig. 4 is a schematic diagram showing the apparatus used in the second preferred embodiment of the invention.

Similar reference characters denote corresponding
15 features consistently throughout the attached drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is an audience rating system for digital television and radio, using identification codes in control streams of time-multiplexed digital transmissions.

The multiplexed digital transmission may be broadcast through the atmosphere by electromagnetic radiation, and/or reflected off satellites orbiting the earth in outer space. Or it may be transmitted by electricity through metal cables, and/or by light through fiber optic cables. Figure 1 is a flowchart illustrating the method in the first preferred embodiment of the invention. Multiplexed digital transmissions are received simultaneously by both an integrated receiver and decoder (hereinafter referred to as the "IRD") connected to the television set or radio (hereinafter referred to as the "receiver"), and by a meter which is also connected to the receiver. (IRDs are now generally separate units attached outside the receiver. But it is expected that eventually they will be placed inside digital receivers during manufacture. The transmission may be received by the meter through an access control card connector, or the meter may have its own tuner, which can be an IRD.) Both the IRD and the receiver must then identify the control stream (sometimes also called the system stream) in the multiplexed digital transmission.

The next step is demultiplexing the multiplexed digital transmission into separate digital streams. The

control stream is used to allocate digital frames to the separate digital streams. In digital television the separate digital streams include at least one video stream for each channel, at least one audio stream for each channel, the control stream itself, and may also include auxiliary streams for each channel. (In digital radio there is, of course, no video stream.) (As used in this application, a "channel" means one or more digital streams that transmit only one program or commercial advertisement at a time, and applies to digital radio as well as television.) Identification codes in the control stream are used to cause only the digital streams of the channel to which the receiver is tuned to be passed to the receiver, so that the channel's audio digital streams are converted to sound, and the channel's video digital streams are converted to pictures.

When the meter receives a signal indicating that the receiver has been turned on, or that the channel that the receiver is tuned to has been changed, the meter selects one or more audio, video and/or auxiliary digital streams belonging to a first channel in the multiplexed digital transmission for comparison with the digital streams of the channel to which the receiver is tuned. If the comparison

shows that the digital streams are identical, the meter then extracts the identification codes of the streams that match from the control stream. If the digital streams are not identical, the meter selects digital streams belonging to the next channel for comparison, and continues selecting and comparing digital streams belonging to each channel in the multiplexed digital transmission, until a match is found, and the identification codes of the matching digital streams received by the meter are extracted from the control stream received by the meter. The identification codes extracted are recorded by the meter, along with the time and date. (If no match is found, a message that the digital stream cannot be identified may be recorded.) (Alternatively, the meter may continuously compare the digital streams in each of the channels in the multiplexed digital transmission to the digital streams in the channel to which the receiver is tuned, and extract and record the identification codes and the time and date whenever the continuous comparison shows that the channel has been changed.) The meter also records the time and date when the receiver is turned off or reception is otherwise ended. Assuming that the times each program and each commercial are transmitted on each channel belonging to each station

are known, the data recorded by the meter makes it possible to determine what stations, channels, programs and commercials members of the audience being monitored are watching or listening to at any particular time.

5 Figure 2 is a schematic diagram showing the apparatus used in the first preferred embodiment of the invention. The digital television station 10 broadcasts (or transmits by cable) a time-multiplexed digital stream 12 containing segments of a control stream C, a video stream V, and an
10 audio stream A. (In practice many video and audio streams would normally be broadcast together in a single time-multiplexed stream, but for the sake of clarity, only a single channel with one of each is shown.) The multiplexed stream is then received and demultiplexed by an integrated
15 receiver and decoder 14 into the control stream (not shown), the video stream 16, and the audio stream 18. The meter 20 independently receives the same multiplexed stream, and likewise demultiplexes it into the control stream and video and audio streams. The video stream of
20 the channel selected is passed to both the cathode ray tube 22 (or liquid crystal display or other visual display device) and the meter, which compares it to each video stream in the multiplexed digital stream. The audio stream

of the channel selected is passed to both the speaker 24 and the meter, which compares it to each audio stream in the multiplexed digital stream. (Of course, in the case of radio, there are no video streams to be compared). The video stream received causes pictures to be displayed by the visual display device, and the audio stream received causes sounds to be emitted by the speaker. Information recorded by the meter may be stored in an internal memory unit for later retrieval. Optionally, in order to instantly generate audience ratings in real time, information recorded in the meter may be transmitted by a cable 26 or other means to a computer 28 where data from many different receivers being simultaneously monitored may be compiled.

Fig. 3 is a flowchart showing the method of the second preferred embodiment of the invention. In the second embodiment, only the IRD receives a multiplexed digital transmission, identifies its control stream, and demultiplexes the separate digital streams. As in the first embodiment, the IRD uses identification codes in the control stream to select the audio and video streams in the channel to which the receiver is tuned, and passes the streams to the receiver, where they are converted into

sound and/or pictures. The IRD extracts the elementary stream for the channel (i.e., the audio, video and auxiliary streams for the channel, and the identification codes for these streams) and makes it available on an auxiliary connector (usually for the purpose of descrambling a controlled access channel) and passes it to the meter, which extracts the identification codes, and records them along with the time and date when the receiver is turned on or the channel that the receiver is tuned to is changed. (Alternatively, the meter may have its own tuner, which can be an IRD with a conditional access module for a specific broadcaster.) As before, the meter also records the time when the receiver is turned off or reception is otherwise ended.

Fig. 4 is a schematic diagram showing the apparatus used in the second preferred embodiment of the invention, showing that the multiplexed digital transmission 12 is received only by the IRC 14, which passes the elementary stream 30 (including an audio stream, a video stream, and identification codes) for the channel to which the receiver is tuned to the meter 20. In the second embodiment, the elementary stream may be accessed by the meter through an auxiliary connector in a digital decoder, or through an

access control card connector, or by soldering an electrical connection to an internal point in the IRD.

In either embodiment, it is possible that a plurality of multiplexed digital transmissions can be received at different frequencies. In this case, when the receiver is turned on, the meter records a first frequency received, and the time reception of the first frequency begins, and when the frequency received is changed, the meter records any subsequent frequency received, and the time reception of the subsequent frequency begins.

Auxiliary streams for a channel may carry binary strings or text characters, by means of which information concerning the station or program being transmitted may be displayed by the receiver. Information concerning programs and/or stations may be displayed in a menu to enable viewers to select transmissions, or to enable viewer to see which transmissions have been selected.

The invention is primarily designed and intended for use in compiling audience rating reports, but may also be used in recording reception of, and billing customers for, pay-per-view digital television programs (or even "pay-per-listen" digital radio programs, should any be developed).

It is to be understood that the present invention is not limited to the preferred embodiments described above, but encompasses any and all embodiments within the scope of the following claims.

CLAIMS

I claim:

1. An audience rating system for digital television and radio, comprising the steps of:

extracting at least one identification code for at least one digital stream of a first channel, from a control stream of a multiplexed digital transmission, when reception of the first channel by a receiver begins;

recording at least one identification code extracted and the time reception of the first channel begins;

extracting at least one identification code for at least one digital stream of any subsequent channel, from the control stream of the multiplexed digital transmission, when reception of the subsequent channel by the receiver begins;

recording at least one identification code extracted and the time reception of the subsequent channel begins;
and

recording the time that reception by the receiver is ended.

2. An audience rating system for digital television and radio according to claim 1, wherein the multiplexed digital transmission is transmitted by electromagnetic radiation.

3. An audience rating system for digital television and radio according to claim 1, wherein the multiplexed digital transmission is transmitted by electricity.

4. An audience rating system for digital television and radio according to claim 1, wherein the identification codes, the time reception of each channel begins, and the time reception ends, are recorded by a meter and stored in a memory unit of the meter.

5. An audience rating system for digital television and radio according to claim 1, wherein the identification codes, the time reception of each channel begins, and the time reception ends, are recorded by a meter and transmitted to a computer.

6. An audience rating system for digital television and radio according to claim 1, wherein the multiplexed digital transmission is received separately by the receiver and by a meter;

when the receiver is turned on, and when the channel that the receiver is tuned to is changed, the meter compares digital streams of the channel that the receiver is tuned to, to digital streams of each of the channels in the multiplexed digital transmission, until it finds a match and extracts at least one identification code for at least one digital stream of the channel from the control stream, and records the identification code along with the time; and

when reception by the receiver is ended, the meter records the time.

7. An audience rating system for digital television and radio according to claim 6, wherein a plurality of multiplexed digital transmissions can be received at different frequencies;

when the receiver is turned on, the meter records a first frequency received, and the time reception of the first frequency begins; and

when the frequency received is changed, the meter records any subsequent frequency received, and the time reception of the subsequent frequency begins.

8. An audience rating system for digital television and radio according to claim 7, wherein:

the receiver has a first tuner; and

the meter has a second tuner which is automatically tuned to the first frequency received when reception begins, and to any subsequent frequency when the frequency received is changed.

9. An audience rating system for digital television and radio according to claim 6, wherein the control stream is accessed by the meter through an access control card connector.

10. An audience rating system for digital television and radio according to claim 1, wherein

when the receiver is turned on, and when the channel that the receiver is tuned to is changed, an elementary stream is extracted from the multiplexed digital transmission, the elementary stream is passed to a meter, the meter extracts at least one identification code from the elementary stream, and the meter records the identification code along with the time; and

when reception by the receiver is ended, the meter records the time.

11. An audience rating system for digital television and radio according to claim 10, wherein the control stream is accessed by the meter through an auxiliary connector in a digital decoder.

12. An audience rating system for digital television and radio according to claim 10, wherein the control stream is accessed by the meter through an access control card connector.

13. An audience rating system for digital television and radio according to claim 10, wherein a plurality of multiplexed digital transmissions can be received at different frequencies;

when the receiver is turned on, the meter records a first frequency received, and the time reception of the first frequency begins; and

when the frequency received is changed, the meter records any subsequent frequency received, and the time reception of the subsequent frequency begins.

14. An audience rating system for digital television and radio according to claim 13, wherein:

the receiver has a first tuner; and

the meter has a second tuner which is automatically tuned to the first frequency received when reception begins, and to any subsequent frequency when the frequency received is changed.

15. An audience rating system for digital television and radio according to claim 14, wherein the first tuner and the second tuner are both integrated receivers and decoders, and the second tuner has a conditional access module for specific broadcaster.

16. A system for recording reception of pay programs on digital television and radio, comprising the steps of:

extracting at least one identification code for at least one digital stream of a first channel, from a control stream of a multiplexed digital transmission, when reception of the first channel by a receiver begins;

recording at least one identification code extracted and the time reception of the first channel begins;

extracting at least one identification code for at least one digital stream of any subsequent channel, from the control stream of the multiplexed digital transmission, when reception of the subsequent channel by the receiver begins;

recording at least one identification code extracted and the time reception of the subsequent channel begins;
and

recording the time that reception by the receiver is ended.

17. An apparatus for audience rating of digital television and radio, comprising:

means for extracting at least one identification code for at least one digital stream of a first channel, from a control stream of a multiplexed digital transmission, when reception of the first channel by a receiver begins;

means for recording at least one identification code extracted and the time reception of the first channel begins;

means for extracting at least one identification code for at least one digital stream of any subsequent channel, from the control stream of the multiplexed digital transmission, when reception of the subsequent channel by the receiver begins;

means for recording at least one identification code extracted and the time reception of the subsequent channel begins; and

means for recording the time that reception by the receiver is ended.

18. An apparatus for audience rating of digital television and radio according to claim 17, wherein the multiplexed digital transmission is received separately by the receiver and by a meter;

when the receiver is turned on, and when the channel that the receiver is tuned to is changed, the meter compares digital streams of the channel that the receiver is tuned to, to digital streams of each of the channels in the multiplexed digital transmission, until it finds a match and extracts at least one identification code for at least one digital stream of the channel from the control stream, and records the identification code along with the time; and

when reception by the receiver is ended, the meter records the time.

19. An apparatus for audience rating system of digital television and radio according to claim 18, wherein a plurality of multiplexed digital transmissions can be received at different frequencies;

when the receiver is turned on, the meter records a first frequency received, and the time reception of the first frequency begins; and

when the frequency received is changed, the meter records any subsequent frequency received, and the time reception of the subsequent frequency begins.

20. An apparatus for audience rating of digital television and radio according to claim 17, wherein

when the receiver is turned on, and when the channel that the receiver is tuned to is changed, an elementary stream is extracted from the multiplexed digital transmission, the elementary stream is passed to a meter, the meter extracts at least one identification code from the elementary stream, and the meter records the identification code along with the time; and

when reception by the receiver is ended, the meter records the time.

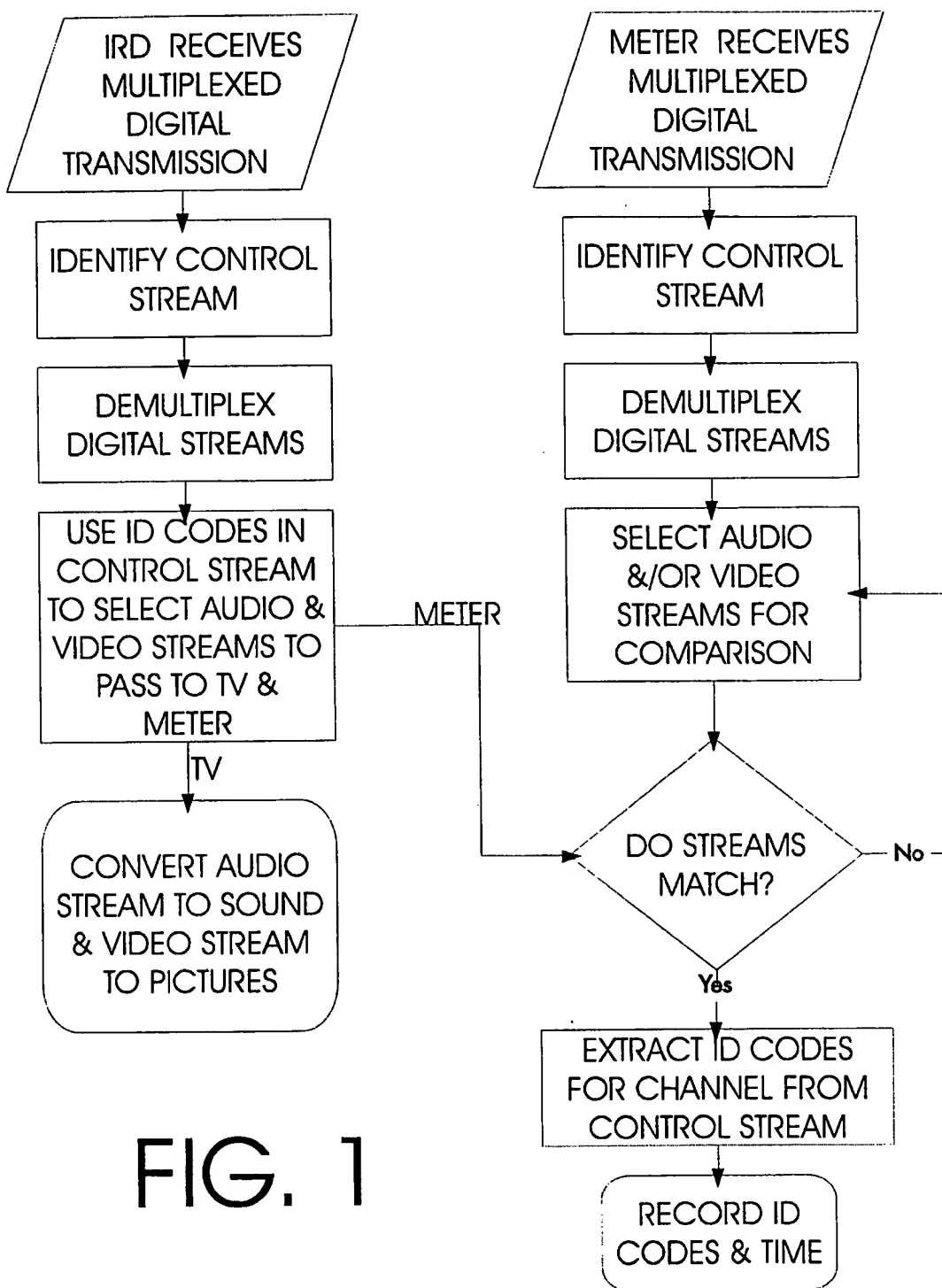
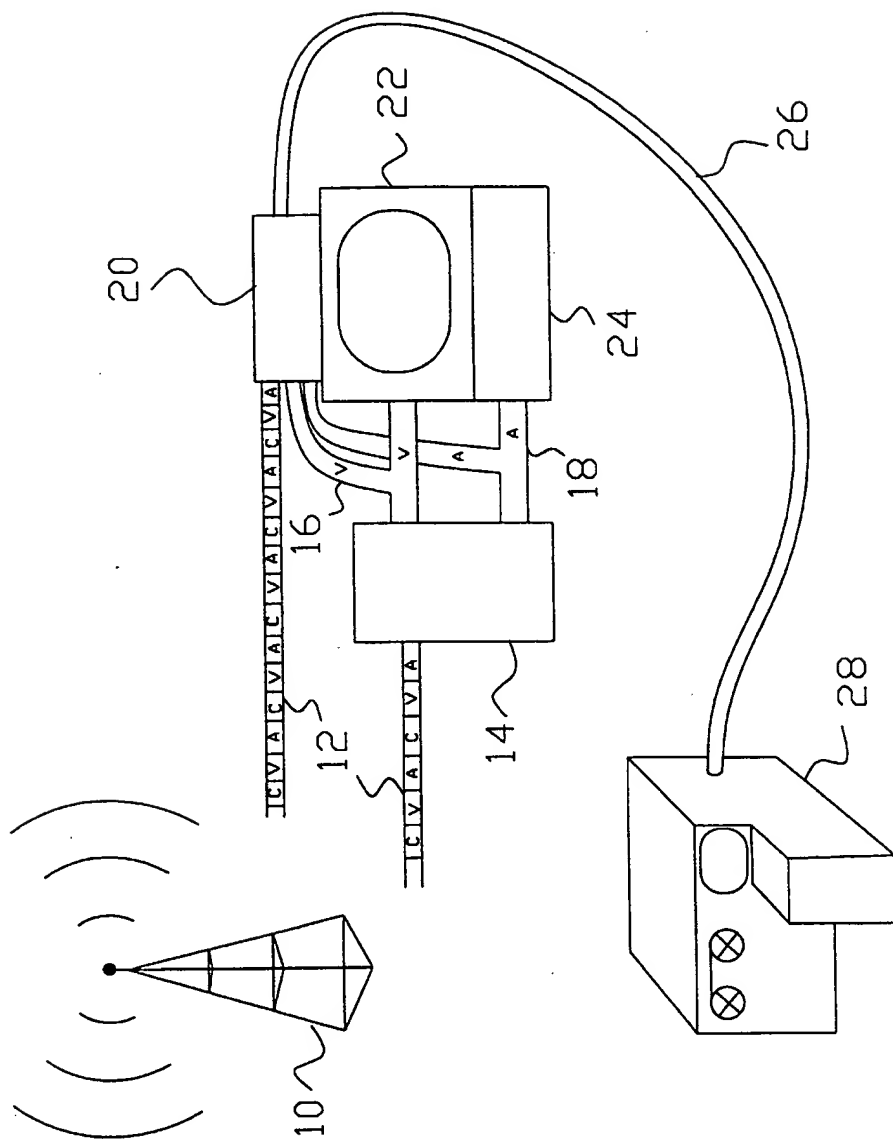
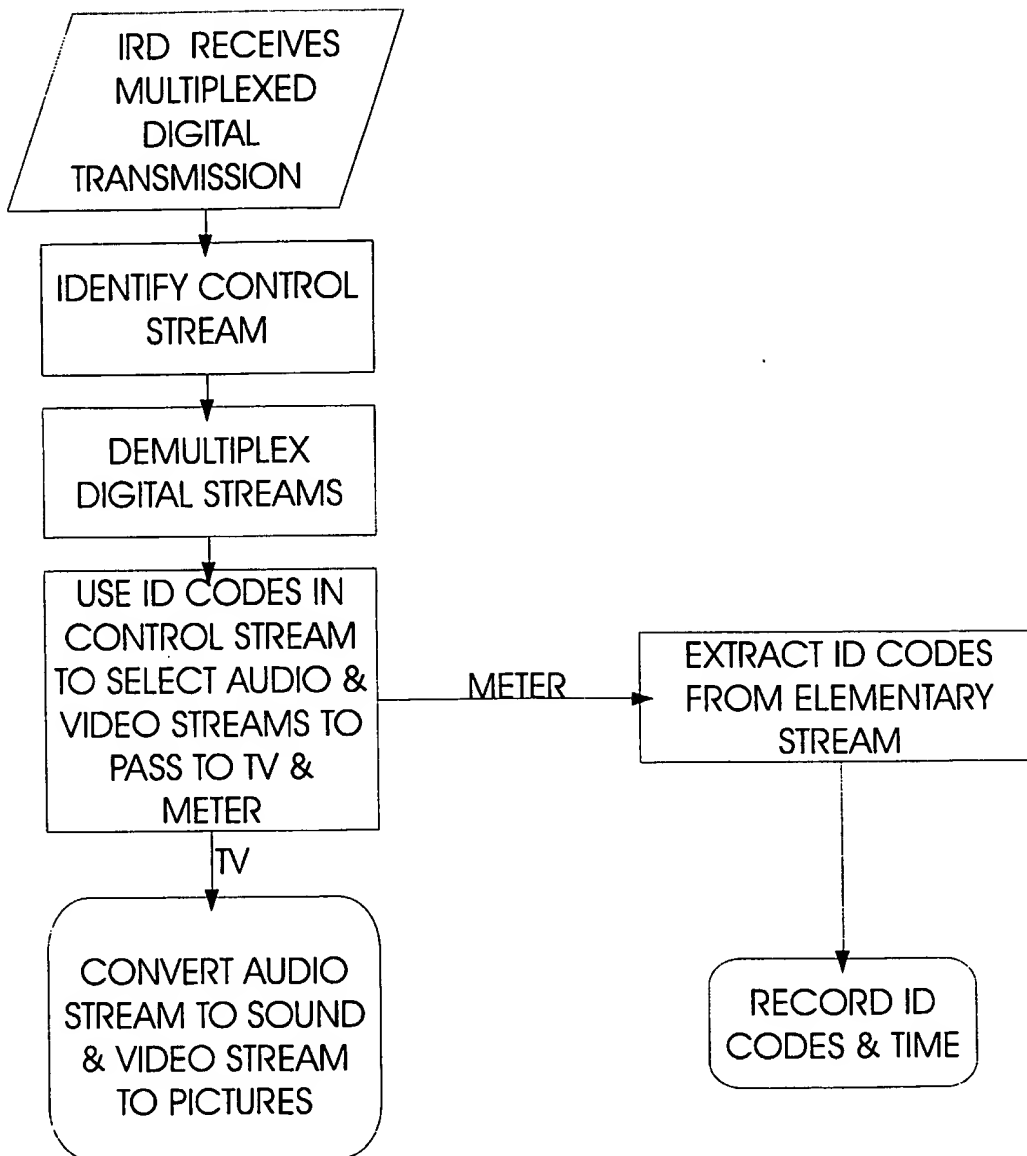


FIG. 1



**FIG. 3**

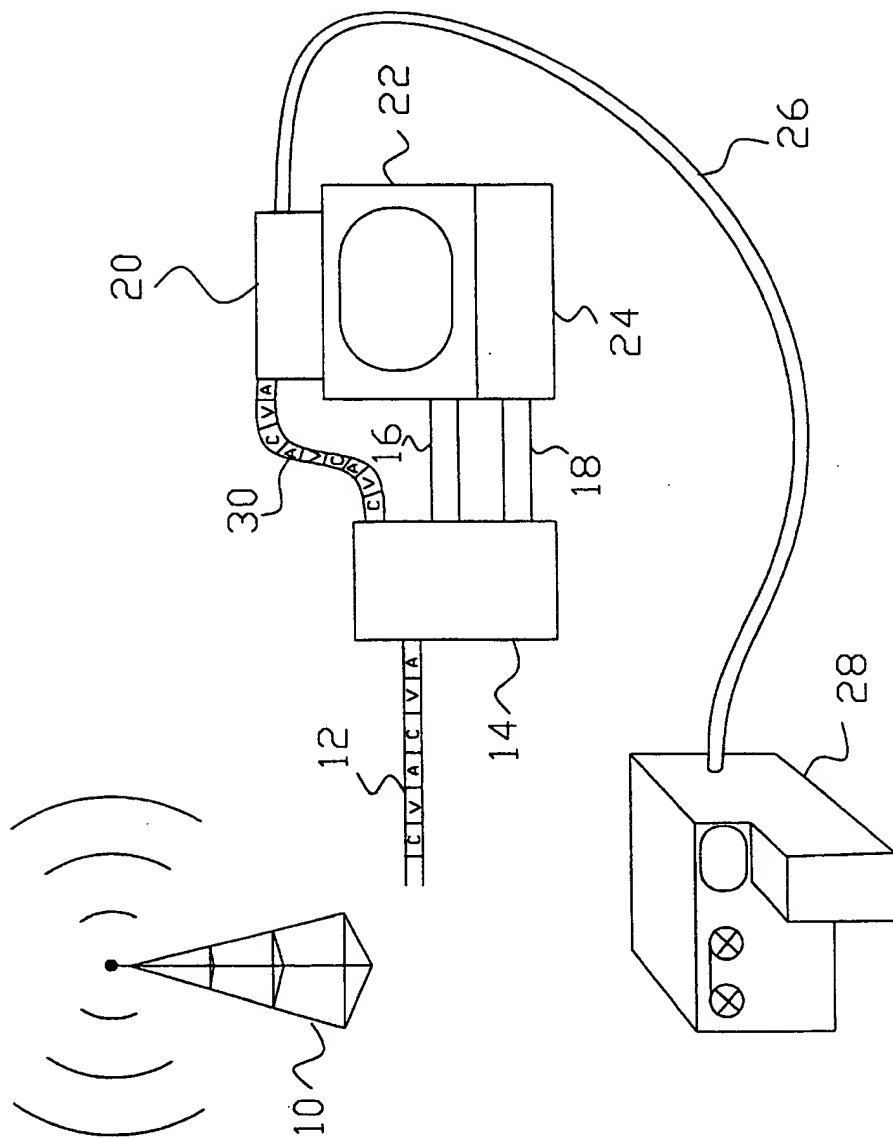


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/10453

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H04N 7/16

US CL : 455/2; 348/1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/2, 4.2, 5.1, 6.1, 6.2, 6.3; 348/1-5, 10,12,13; H04N 7/16, 7/173

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms:survey, rating, digital, digitiz?, multiplex?, time, channel?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| A, P | US 5,872,588 A (ARAS et al.) 16 February 1999 whole document | 1-20 |
| A | US, 5,594,934 A (LU et al.) 14 January 1997 figure 1 | 1-20 |
| A | US 5,532,732 A (YUEN et al.) 02 July 1996 figure 6 | 1-20 |
| A | US 5,659,350 A (HENDRICKS et al.) 19 August 1997 column 15 | 1-20 |

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document published on or after the international filing date

I document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Z

document member of the same patent family

Date of the actual completion of the international search

17 JULY 1999

Date of mailing of the international search report

23 AUG 1999

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